3-25-2017

Understanding the Role of Business Analytics Applications in Healthcare Value Chain

Rudolph Bedely
The University of North Carolina at Greensboro, rtbedele@uncg.edu

UNDERSTANDING THE ROLE OF BUSINESS ANALYTICS APPLICATIONS IN HEALTHCARE VALUE CHAIN

Rudolph Bedely
The University of North Carolina at Greensboro
rtbedele@uncg.edu

ABSTRACT

This research explores how healthcare organizations are leveraging business analytics (BA) capabilities and techniques to create value and improve care quality. Given the increasing interest and investment in BA, it is important to have a good understanding of what analytics capabilities healthcare organizations are utilizing to enhance value. Using Burns et al. (2002) healthcare value chain framework as a basis, we will identify the various analytics techniques/capabilities and subsequently classify them into three generally accepted classification of analytics: descriptive, predictive and prescriptive. Based on extensive search of the literature, complimented by a follow-up case study of a large regional hospital, analytics applications will be mapped onto the healthcare value chain framework. The study will contribute to practice and academia by clearly illustrating how healthcare organizations currently utilizes or should be using analytic capabilities and techniques in order to enable them close the quality gaps.

Keywords: healthcare, business analytics, descriptive, predictive, prescriptive, capabilities, value chain

INTRODUCTION

Concerns about the quality of care and economic sustainability in healthcare have existed for years all over the world (Dinev, T., Albano, V., Xu, H., & D'Atri, A., 2016). Government agencies and businesses who are involved in providing health coverage for workers and citizens have long called for cost control (Dinev et al. 2016). In the United States, a published report from the Business Roundtable, which represents CEOs of major companies has concluded that the US healthcare system has become a liability that hinders companies' as well as healthcare organizations' competitiveness in a global economy (Alonso-Zaldivar 2009). As an additional twist, the report found that higher U.S. spending fails to deliver a healthier work force, thus creating the largest "value gap" between cost and benefits among healthcare systems.

The healthcare sector has drawn the attention of many healthcare providing organizations to seek better ways to re-engineering their current methods of operation. As a result, emphasis on the adoption and use of BA tools and techniques has since been increasingly enforced by many healthcare organizations as one of the most efficient ways to streamline healthcare processes and operations in order to achieve better quality of care delivery and overall performance (Agarwal, Gao, DesRoches, & Jha, 2010; Chen, Chiang, & Storey, 2012). However, while there have been several studies on the adoption and impact of BA on organizational performance, only a few studies in the Information Systems discipline have investigated BA impacts on quality of care in the healthcare sector (Sharma et al., 2014; Wang, Kung, & Byrd, 2016).

Business analytics has been defined as "the study of data to discover potential trends, analyze the effects of certain decisions or events, or to evaluate the performance of a given tool or scenario, with the goal of improving outcomes through greater knowledge" (Reiner 2013, p. 826). While analytics have permeated all aspects of business to date, healthcare analytics represent an area of extremely high and untapped potential (Wang et al., 2016). The McKinsley Global Institute (MGI) estimates that big data analysis (i.e., analysis of large datasets) could save the U.S. healthcare system 300 billion dollars annually, with two thirds of that saving in the form of decreasing expenditures by 8 % (Gartner 2012; Reiner 2013).

A systemic review of the extant literature reveals that several studies have proposed models, typologies and domains to study the impact of BA on organizations (Chen et al. 2012; Holsapple et al. 2014; Wixom et al. 2013). Other studies have focused on the supply chain analytics capabilities of organization from a resource-based view (Barney 1991) and dynamic capabilities perspectives (Eisenhardt & Martin 2000) (Chae & Olson 2013). Whiles these studies have generally shown that relationship exist between BA adoption and organizational performance (operations, financial, etc.), there is – to the best of our knowledge – no study that has yet systematically investigated or shown how BA is being utilized in healthcare organizations to improve quality of care and financial performance.

Thus, the healthcare industry currently lags behind significantly in taking full advantage of current and emerging state-of-the art BA tools and methods (Ferranti, Langman, Tanaka, McCall, & Ahmad, 2010). Many healthcare organizations are struggling today with the implementation of BA techniques and technologies even though they invest in numerous analytics systems and applications with the hope of achieving major transformation in their daily care processes and performance (Murdoch & Detsky, 2013; Shah & Pathak, 2014). Moreover, evidence from a survey also shows that 60% of healthcare organizations surveyed fail to develop a clear, integrated enterprise strategy and vision for analytics deployment across a broad range of functions (Deloitte Center for health Solutions, 2015). One of the reasons for the low interest of BA implementation in healthcare organizations is basically as a result of lack of understanding of the economic potentials and implications of BA adoption (Groves, Kayyali, Knott, & Kuiken, 2013; Murdoch & Detsky, 2013).

Evidenced by the above gaps in the literature, we conclude that the current stream of research on BA has focused mainly on addressing BA implementation issues pertinent to most industries. However, research on BA implementation in healthcare is significantly lacking and as such, healthcare organizations are currently in their early stages of taking full advantage of BA techniques to address issues related to strategic choices and resource configurations (Xu, Frankwick, & Ramirez, 2016), as well as issues related to comprehensively understanding the managerial, economic, and strategic impact of BA (Raghupathi & Raghupathi, 2014; Ward et al., 2014). We further argue, therefore, that without reasonable guidelines backed by theory, not only is it difficult to help healthcare practitioners focus priorities and efforts on deriving value from the adoption of BA, but they also cannot find sufficient evidence to support the argument of how BA investment can pay off (Murdoch & Detsky, 2013; Shah & Pathak, 2014).

Given this gap, and still limited understanding of the business value of BA implementation in healthcare organizations, this research is being conducted to address the following key research question:

How can BA techniques, methods and technologies be effectively applied to improve quality of care and financial performance in healthcare organizations?

More specifically, we answer the above higher level research question by breaking it down into the following sub-questions:

1) *What BA techniques and tools are healthcare organizations currently implementing within the different domains of their value chain network?*
2) *How are the various analytic capabilities being applied in the different areas of the value chain in healthcare organizations?*
3) *What are some of the organizational challenges facing successful implementation of BA techniques and technologies in a healthcare organization?*
4) *How are these challenges currently being addressed within the healthcare industry?*

In addressing these research questions, we use mixed-method research approach by specifically applying a combination of content analysis and case study that is currently being conducted in a large healthcare organization through interviews. First, we begin with extensive review of both academic and practitioner literature to uncover documented cases of BA applications in different healthcare organizations. Thereafter, each application is being analyzed separately from two distinct standpoints: its categorical BA classification and its primary placement within the context of the value chain framework proposed by Burns, DeGraaff, Danzon, Kimberly, Kissick, & Pauly (2002). This will then be used to develop the mapping of analytic techniques and capabilities as they are applied in specific areas of the value chain framework of healthcare organizations. Based on the findings, our future research will focus on developing a process model for how effective application of analytics can add value to healthcare organizations. .

RELEVANT LITERATURE AND THEORETICAL FOUNDATION

The healthcare value chain framework was introduced in the healthcare industry during the early 1990s as a result of several major developments such as vertical integration, horizontal integration, managed care pressures, changes in federal reimbursement policies, the evolution of e-commerce, and the passage of the Health Insurance Portability and Accountability Act (HIPAA) in 1996 (Burns et al., 2002). This study aims to get granular insight into which specific analytics techniques and capabilities are applied within each of the different segments of the healthcare value chain presented in Figure 1 below.

The study draws on the concepts of Burns et al. (2002) value chain framework which was proposed to basically explain how healthcare organizations are creating value through their primary and secondary activities. In the healthcare context, however, a more modified form of Porter's (1985) original value chain has proved useful in understanding how various activities tailored toward quality of care delivery fit together (Sastry 2014). Burns et al. (2002) developed a more conventional value chain framework specifically for healthcare organizations (Figure 1). In the context of healthcare, the value chain framework

redefined a reversed order in such a way that the support activities, which comprise of hospital support services; hospital diagnostic and therapeutic services; information services; and hospital administration, collectively form the foundation activities whiles the primary activities, which include admission; care; discharge; marketing and sales; and service constitute the front-end activities. Healthcare organizations depend on this configuration of value-chain mapping to figure out how to improve quality (or lower costs) of care by delivering or connecting patients to the services in order to fully benefit from the entire chain of activities needed for better care (Sastry, 2014).

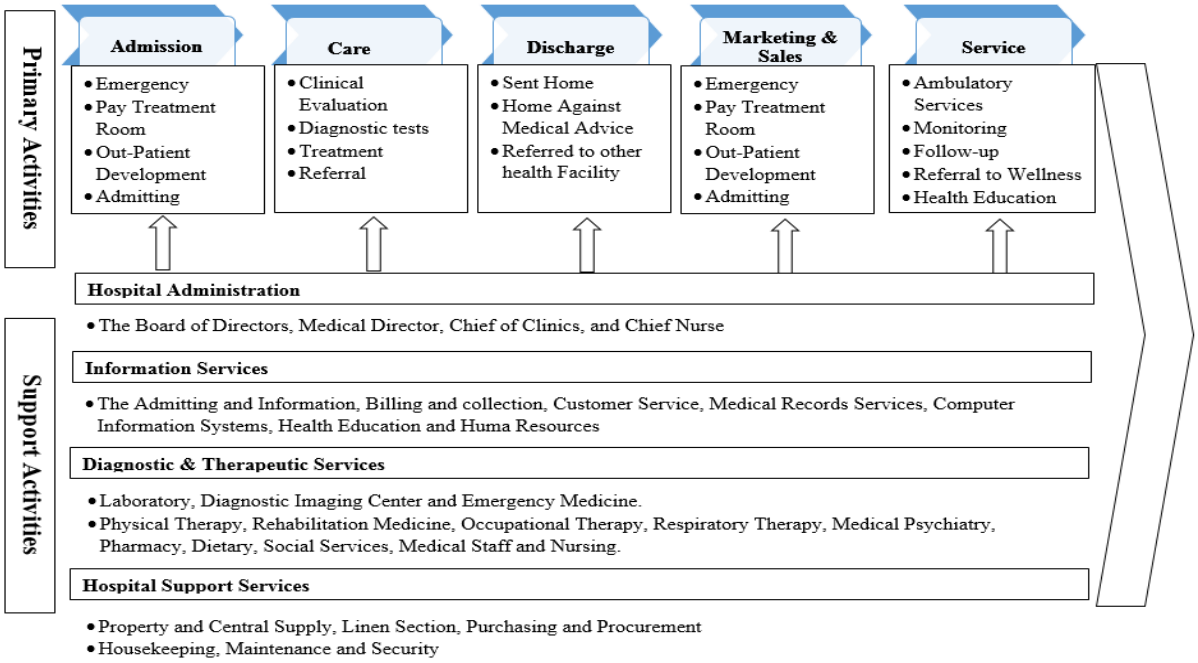

Figure 1. Healthcare Value Chain Framework (Adapted from Burn et al., 2002)

METHODOLOGY

This study is currently being conducted mainly through content (literature) analysis and interviews to enable us address the research questions. This approach is appropriate because review of academic and practice literature to accomplish similar purposes is common in IS literature (Zafar and Clark 2009; Zhao & Zhu 2012; Phillips-Wren et al. 2015). For instance, a recent study by Bedeley, Ghoshal, Iyer and Bhadury (2016) have used similar methodology to map the various BA capabilities and applications at each of the different regions of Porter's (1985) Value Chain Framework for all industries.

DATA COLLECTION AND ANALYSIS

Secondary Data (Content Analysis)

Currently, thorough literature review of analytics applications, technologies and processes used in different levels of analytics tasks from a value chain perspective is being conducted. The main purpose of the literature review is to identify the prominent exemplars of the usage of analytics in different value chain activities and processes. For the literature search, keywords being used include 'analytics', 'value chain', "HIT", "EHR", "EMR" and combinations of different levels of analytics (descriptive, predictive and prescriptive) with different value chain activities. The data source includes academic journals (e.g. MIS Quarterly, ISR, JMIS, Decision Support Systems, etc.), practitioners' journals (e.g. MIS Quarterly Executive, Journal of Medical Systems, McKinsey & Company Publications, etc.), academic and practitioners' conference publications, publications from research organizations, white papers, periodicals, etc. Again, the objective of this literature analysis is to identify the analytics capabilities and applications, i.e., tools, technologies, and processes used in organizations' value chain.

Primary Data (Case Study)

Parallel to the content analysis study, we are also conducting interviews with the healthcare organization participating in this study in order to obtain a richer and granular information to substantiate the findings from the literature (content analysis). The Healthcare Organization (HCO) being used as a case study in this research is one of the largest and highly reputed care

providing organizations (ranks among the top 2% best "High Performing" care systems in US) located in the South-Eastern part of the U.S. This HCO is an integrated non-for-profit health care network serving people living in five major counties with the primary objective of providing excellent and quality of care for its patients.

This healthcare organization is deemed appropriate to be used as our case subject because not only is it currently growing and expanding its operations but also because management have expressed great interest in investing huge sum of dollars to elevate the current analytics strategies, techniques and capabilities to the world class level. The organization expressed great interest in our research project because management wants to know how their current state of analytics capabilities and applications compare with other leading healthcare organizations, and also to help them make inform decision on which specific analytics techniques and applications they should invest in the more. In this regards, top management of the healthcare organization has agreed to provide all the necessary support with regards to data collection and other necessary logistics we need to ensure that this research project is successfully executed.

Through the use of semi-structured interviews, primary data is being collected over a period of 8 months, starting from May to December, 2016. While we anticipate to interview between 10-20 employees with some knowledge or experience in BA use and applications, we have so far interviewed 6 people within this healthcare organization. The informants comes from varying education and qualification background, with an average of 19 years of rich experience in business analytics (BA), business intelligence (BI) and other IT related services. The current job titles or position held by informants include: the Executive Director of Healthcare Analytics (*R1*); the Director of Clinical Business Intelligence Unit (*R2*); The Director of Meaningful Use (*R3*); Health Informatics Analyst (*R4*); the Instructional Designer in Charge of Epic Operations (*R5*); and the HIM/Identity Instructional Designer (*R6*)**.** The informants were randomly assigned pseudonyms, *R1, …, Rn,* (see Table 5) in order to protect their identity based on initial data masking agreement reached.

The idea of using multiple informants from variety of functional backgrounds and levels originated from Phillips (1981), who strongly argued that multiple informants are more reliable sources of data collection than just a single one. Table 1 below summarizes demographic and other background information for each of the informants that have been interviewed so far.

#	Informant	Job Title/Position	Education Level	Years of IT-related Work Experience
1	*R1*	Executive Director of Health Analytics	MSc in Nursing & Certificate in Business	16
2	*R2*	Director of Clinical Business Intelligence	BSc. in Information Technology	24
3	*R3*	Director of Meaningful Use	MBA, RHIA	40
4	*R4*	Health Information Analyst	BSc. in Information Technology	12
5	*R5*	Instructional Designer (Epic Operations)	MSc. in Information Technology	12
6	*R6*	Health Information Management/Identity Instructional Designer	MSc. in Health Administration	10

Table 1. Interviewees Background Information

DATA ANALYSIS

During the content analysis process, the researchers documented words, phrases, sentences, and/or paragraphs that reveal any of the three analytics type and its usage within an organization. These words, phrases, etc. were then coded based on common themes that have been agreed on prior to the analysis. The types of analytics capabilities or applications identified from the analysis will then be mapped onto the various components of the healthcare value chain framework.

A research associate will assist in analyzing the data after which researchers will exchange their findings and then cross-validate their results by comparing and contrasting prior independent analysis. During this process, any discrepancies in findings will be resolved by identifying common themes that emerge from the two independent analysis. Final mapping will then be conducted after exhaustive analysis and series of discussions between all researchers involved in the study.

In addition to the literature findings, the interviews will be used to triangulate and validate earlier results. Once each interview session was completed, the researchers typed the field notes and transcribed the recording. Transcripts were compared and contrasted between researchers and eventually consolidated into one final document which were then sent back to the respective informant for content validation. After the transcription, the process of unitizing and categorizing was carried out in a qualitative

data analysis software (Atlas.ti) program which helped make more sense of the datasets. Unitizing is the coding operation in which information is isolated from the text. The emerging themes for various sections were identified from the transcripts.

PRELIMINARY FINDINGS

While data collection and analysis are still in progress, the initial results of the data analyzed thus far reveal that the healthcare organizations are still in the early stages of fully embracing and leveraging BA techniques and technologies. So far, the HCO has just begun (less than 1 year) investing huge sum of dollars in building its giant Enterprise Data Warehouse (EDW) and therefore looking into implementing some of the modern BA applications or technologies to enable them do more real-time predictive analytics and be able to develop data-driven models to improve their operational and financial performance. This findings confirms that majority of even leading healthcare organizations lacks behind in the adoption and implementation of cutting-edge BA techniques and applications as captured in the following excerpt from R2's response:

R2: "*I haven't really heard of anyone in the healthcare area with leading edge implementation of latest business analytics techniques and applications. I know that a lot of people are trying right now but I haven't seen any output. Usually, the leaders are the e-commerce businesses and the social media giants like the Amazon, Google, Facebook, etc. because they are actually implementing something new day by day and realizing results out of it."*

Vast number of BA technologies are currently in the market with each technology being purposely designed to effectively perform a specific task in order to gain the best business value. In terms of data storage, HCO is still utilizing the traditional SQL databases even though the organization is also considering migrating onto Hadoop in the near future as revealed in *R1'*s response:

R1 *"Yeah there are a few of the technologies we look at – some of them are being implemented and some of them are being planned. Hadoop is one of them, Splunk is one them, Cassandra is another and a lot of other NoSQL Big Data technologies like people look into Teradata, Vertica, Elastic Search, Solr, etc. and for real-time we look into Splunk, Flumes etc. Because even Hadoop is a big ecosystem with a lot technologies inside it – Hive, Hbase, Pig, etc. – so there are different groups in different divisions of the firm looking into different things."*

CONCLUSION AND IMPLICATION OF STUDY

This research-in-progress is being conducted to explore how healthcare organizations are harnessing BA capabilities and techniques to improve their operations and processes, and consequently enhance their value. The study employs a combination of two research approaches namely: content analysis and case study to address research questions. Different analytics capabilities and tools will be presented in a tabular format where the rows will represent BA techniques and capabilities belonging to either primary or supporting activities of the value chain, while the three column heading of the table will identify analytics capabilities as either being descriptive, predictive, and/or prescriptive.

Findings from this research will have far-reaching impact on both practice and academia. For practitioners, this research will help to not only be able to catalog BA systems according to different value chain activities but also allow managers in various healthcare organizations to carefully evaluate how different BA systems in different value chain activities can impact and create overall value in their organizations. For academics, the framework will be evaluated empirically to understand actual relationship between specific BA use and healthcare organizations overall performance. This should begin with studies that focus on delineating the specific organizational cultural and analytic infrastructural and capabilities variables that are germane to the different parts of the value chain. For example, it is quite conceivable that infrastructural/capability variables such as "Skills" will be different for "Marketing and sales" than for another aspect of the healthcare value chain.

REFERENCES

1. Agarwal R., Gao, G., DesRoches C. and Jha A.K. (2010) The digital transformation of healthcare: current status and the road ahead. Information System Research 21(4):796–809
2. Alonso-Zaldivar, R. (2009) U.S. healthcare lags in bang for the buck. San Francisco Chronicle, March 12, p. 1.
3. Barney, J. (1991) "Firm Resources and Sustained Competitive Advantage," Journal of Management (17:1), pp. 99–120.
4. Bedeley, R., Ghoshal, T., Iyer, L.S., and Bhadury, J. (2016) Business Analytics and Organizational Value Chains: A Relational Mapping, Journal of Computer Information Systems, http://dx.doi.org/10.1080/08874417.2016.1220238.
5. Burns, L.R., DeGraaff, R. A., Danzon, P.M., Kimberly, J.R., Kissick, W.L. and Pauly, M.V. (2002) The Wharton School Study of the Health Care Value Chain,

6. Chae, B., and Olson, D. L. (2013). "Business analytics for supply chain: A dynamic-capabilities framework," International Journal of Information Technology & Decision Making (12:1), pp. 9–26.
7. Chen, H., Chiang, R. H. L., and Storey, V. C. (2012) Business intelligence and analytics: From big data to big impact, MIS Quarterly (36:4), MIS Quarterly, pp. 1165–1188.
8. Deloitte Center for health Solutions (2015). Health system analytics: The missing key to unlock value-based care. Deloitte Development LLC.
9. Dinev, T., Albano, V., Xu, H., D'Atri, A., and Hart, P. (2016) Individuals' Attitude Towards Electronic Healthcare Records: A Privacy Calculus Perspective, Anals of Information Systems, 19
10. Eisenhardt, K. M., and Martin, J. A. (2000) Dynamic capabilities: What are they, Strategic management journal (21:1), pp. 1105–1121.
11. Ferranti, J.M, Langman, M.K., Tanaka, D., McCall, J. & Ahmad, A. (2010) Bridging the gap: leveraging business intelligence tools in support of patient safety and financial effectiveness, J Am Med Inform Assoc. 2010 Mar-Apr;17 (2):136-43. doi: 10.1136/jamia.2009.002220.
12. Gartner. (2012) Gartner Says Worldwide Business Intelligence, Analytics and Performance Management Software Market Surpassed the $12 Billion Mark in 2011," (available at http://www.gartner.com/newsroom/id/1971516; retrieved May 1, 2015).
13. Groves, P., Kayyali B., Knott D., and Van Kuiken, S. (2013) The Big Data Revolution in Healthcare. McKinsey & Company Center for U.S. Health System Reform Business Technology Office;
14. Holsapple, C., Lee-Post, A., and Pakath, R. (2014) A unified foundation for business analytics, Decision Support Systems (64), pp. 130–141.
15. Murdoch, T.B. and Detsky, A.S. (2013) The inevitable application of big data to health care, Journal of American Medical Association, Vol. 309 (13), pp. 1351–1352.
16. Porter, M. E. 1985. Competitive Advantage, New York: The Free Press.
17. Raghupathi, W. and Raghupathi, V. (2014) Big data analytics in healthcare: promise and potential. Health Information Science System; 2:3. Available at: http://www.hissjournal.com/content/2/1/3.
18. Reiner, B.I. (2013) Creating Accountability in Image Quality Analysis. Part 4: Quality Analytics Journal of Digital Imaging, Vol. (26), pp. 825-829.
19. Sastry, A. (2014) Mapping processes and value chains to understand strategy in care delivery," Groundwork Initiative for Global Health at MIT Sloan,
20. Shah, N.D, and Pathak J. (2014) Why Health Care May Finally Be Ready for Big Data. Harvard Business Review.
21. Wang, Y., Kung, L-A., and Byrd, T.A. (2016) Big data analytics: Understanding its capabilities and potential benefits for healthcare organizations, Technological Forecasting & Social Change, http://dx.doi.org/10.1016/j.techfore.2015.12.019
22. Ward, M.J., Marsolo, K.A., & Froehle, C.M. (2014) Healthcare: An Industry In Need of Analytics, *PubMed Central*, 57(5): 571–582
23. Wixom, B. H., Yen, B., Relich, M., Wixom, B. H., Yen, B., and Relich, M. (2013) Maximizing Value from Business Analytics, MIS Quarterly Executive (12:2), pp. 111–123.
24. Xu, Z., Frankwick, G. L., and Ramirez, E. (2016). Effects of Big Data analytics and traditional marketing analytics on new product success: A knowledge fusion perspective. Journal of Business Research, 69(5), 1562–1566.